

U.S.S.N. 10/649,145 (DP-309271) - 2**LISTING OF THE CLAIMS:**

1. – 9. (canceled)

10. (currently amended) A device to regulate current provided to a permanent magnet machine responsive to a plurality of phase current signals to produce torque on a shaft comprising:

a processing and drive circuit responsive to a direct voltage command signal (Vds) and a quadrature voltage command signal (Vqs) to produce the plurality of phase current signals for input to the permanent magnet machine;

a command circuit responsive to a torque input and configured to produce a direct current command signal (Ids) and a quadrature current command signal (Iqs);

a D-axis control circuit responsive to the direct current command signal (Ids) to produce the direct voltage command signal (Vds), the D-axis control circuit comprising a first clamp configured to limit the direct voltage command signal (Vds) to values less than or equal to a preselected level that is less than or equal to a voltage magnitude command signal (Vmag*);

a Q-axis control circuit responsive to the quadrature current command signal (Iqs) to produce the quadrature voltage command signal (Vqs), the Q-axis control circuit comprising a second clamp configured to limit the device of claim 10 wherein the second clamp limits said quadrature voltage command signal (Vqs) in accordance with the following in a motoring mode:

$$MIN \leq Vqs \leq \left[\sqrt{Vmag^{*2} - Vds^2} \right] * K .$$

11. (currently amended) A device to regulate current provided to a permanent magnet machine responsive to a plurality of phase current signals to produce torque on a shaft comprising:

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a processing and drive circuit responsive to a direct voltage command signal (Vds) and a quadrature voltage command signal (Vqs) to produce the plurality of phase current signals for input to the permanent magnet machine;

a command circuit responsive to a torque input and configured to produce a direct current command signal (Ids) and a quadrature current command signal (Iqs);

a D-axis control circuit responsive to the direct current command signal (Ids) to produce the direct voltage command signal (Vds), the D-axis control circuit comprising a first clamp configured to limit the direct voltage command signal (Vds) to values less than or equal to a preselected level that is less than or equal to a voltage magnitude command signal (Vmag*);

a Q-axis control circuit responsive to the quadrature current command signal (Iqs) to produce the quadrature voltage command signal (Vqs), the Q-axis control circuit comprising a second clamp configured to limit The device of claim 20 wherein the second clamp limits said quadrature voltage command signal in accordance with the following in a generating mode:

$$MIN \leq Vqs \leq (Vmag *) * K .$$

12. (previously presented) A device to regulate current provided to a permanent magnet machine responsive to a plurality of phase current signals to produce torque on a shaft comprising:

a processing and drive circuit responsive to a direct voltage command signal and a quadrature voltage command signal, said processing and drive circuit configured to produce said plurality of phase current signals for input to said permanent magnet machine;

a current regulator including,

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a command circuit responsive to a torque input command signal configured to produce a direct current command signal and a quadrature current command signal;

a control circuit responsive to the direct and quadrature current command signals configured to produce said direct and quadrature voltage command signals; and

a limiter configured to limit the direct and quadrature voltage command signals to a preselected level, wherein said limiter is operative to limit said direct voltage command signal (V_{ds}) and said quadrature voltage command signal V_{qs} as follows:

$$V_{ds} = -V_{mag} * [\sin(\Delta \text{ Maximum})],$$

$$V_{qs} = V_{mag} * [\cos(\Delta \text{ Maximum})],$$

Where Δ is greater than Δ Maximum and where Δ is defined as follows:

$$\Delta = \arctan(-V_{ds}/V_{qs}) \text{ and}$$

where Δ must be within the following range:

$$\Delta \text{ Minimum} \leq \Delta \leq \Delta \text{ Maximum}.$$

13. (previously presented) A device to regulate current provided to a permanent magnet machine responsive to a plurality of phase current signals to produce torque on a shaft comprising:

a processing and drive circuit responsive to a direct voltage command signal and a quadrature voltage command signal, said processing and drive circuit configured to produce said plurality of phase current signals for input to said permanent magnet machine;

a current regulator including,

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a command circuit responsive to a torque input command signal configured to produce a direct current command signal and a quadrature current command signal;

a control circuit responsive to the direct and quadrature current command signals configured to produce said direct and quadrature voltage command signals; and

a limiter configured to limit the direct and quadrature voltage command signals to a preselected level, wherein said limiter is operative to limit said direct voltage command signal (V_{ds}) and said quadrature voltage command signal (V_{qs}) as follows:

$$V_{ds} = -V_{mag} * [\sin(\Delta \text{ Minimum})]$$

$$V_{qs} = V_{mag} * [\cos(\Delta \text{ Minimum})]$$

Where Δ is less than Δ Minimum, and where Δ is defined as follows;

$$\Delta = \arctan(-V_{ds}/V_{qs}) \text{ and}$$

where Δ must be in within the following range:

$$\Delta \text{ Minimum} \leq \Delta \leq \Delta \text{ Maximum.}$$

14. – 18. (canceled)

19. (currently amended) A device to regulate current provided to a permanent magnet machine responsive to a plurality of phase current signals to produce torque on a shaft comprising:

a processing and drive circuit responsive to a direct voltage command signal (V_{ds}) and a quadrature voltage command signal (V_{qs}) to produce the plurality of phase current signals for input to the permanent magnet machine;

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a command circuit responsive to a torque input and configured to produce a direct current command signal (I_{ds}) and a quadrature current command signal (I_{qs});

a D-axis control circuit responsive to the direct current command signal (I_{ds}) to produce the direct voltage command signal (V_{ds}), the D-axis control circuit comprising a first clamp configured to limit the direct voltage command signal (V_{ds}) to values less than or equal to a preselected level;

a Q-axis control circuit responsive to the quadrature current command signal (I_{qs}) to produce the quadrature voltage command signal (V_{qs}), the Q-axis control circuit comprising a second clamp configured to limit the quadrature voltage command signal (V_{qs}) in a the motoring mode to values less than or equal to a quadrature voltage command signal limit value derived from the square root of the absolute difference between the square of quantity $((V_{mag}^*)^2 - (V_{ds})^2)$, where V_{mag}^* is a the voltage magnitude command signal ($V_{mag}^*)$ and the square of the direct voltage command signal (V_{ds}).

20. (currently amended) A device to regulate current provided to a permanent magnet machine responsive to a plurality of phase current signals to produce torque on a shaft comprising:

a processing and drive circuit responsive to a direct voltage command signal (V_{ds}) and a quadrature voltage command signal (V_{qs}) to produce the plurality of phase current signals for input to the permanent magnet machine;

a command circuit responsive to a torque input and configured to produce a direct current command signal (I_{ds}) and a quadrature current command signal (I_{qs});

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a D-axis control circuit responsive to the direct current command signal (I_{ds}) to produce the direct voltage command signal (V_{ds}), the D-axis control circuit comprising a first clamp configured to limit the direct voltage command signal (V_{ds}) to values less than or equal to a preselected level;

a Q-axis control circuit responsive to the quadrature current command signal (I_{qs}) to produce the quadrature voltage command signal (V_{qs}), the Q-axis control circuit comprising a second clamp configured to limit the quadrature voltage command signal (V_{qs}) in a generating ~~the metering~~ mode to values less than or equal to a quadrature voltage command signal limit value derived from ~~the quantity~~ V_{mag}^* , where V_{mag}^* is a the voltage magnitude command signal (V_{mag}^*).